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The role of local development plans in addressing climate change: A case study of Isfahan metropolitan city, Iran☆

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ABSTRACT

Development plans, as strategic documents that guide investment and organize the spatial structure of a city, must be sensitive and responsive to the increasing risks posed by climate change. However, it remains unclear which explicit and implicit policies these plans propose to address climate issues and how these policies align within the dual frameworks of "adaptation" and "mitigation, the primary strategies for combating climate change. Thus, a comprehensive study is required to identify these policies as key climate themes, to map the network of relationships among them, and to assess the extent to which development plans incorporate each of the proposed approaches for addressing climate change in the local development plans. This research aims to clarify how both implicit and explicit key climate themes are reflected in local development plans in response to climate change. This study used an integrative approach, employing a "reflexive-network" analysis of themes to examine the content of the data. Seven recent development plans from the Isfahan metropolitan city were analyzed as a case study. The results indicate that adaptation policies to climate change are more prominently emphasized than emission reduction and source control policies. However, the plans show insufficient internal coherence and continuity. The results indicate that the marginalization of climate change is primarily due to insufficient climate awareness, weak climate planning, and institutional fragmentation. Therefore, three policy areas are proposed: reforming economic priorities, enhancing climate planning and literacy, and promoting institutional integration.

1. Introduction

Climate change has presented profound and unprecedented threats and challenges to cities worldwide, especially those in developing countries experiencing rapid urbanization [1–4]. These transformations are expected to be among the main drivers of physical and social changes in urban environments [5–12]. Therefore, cities must be equipped with effective tools and strategies to address the consequences of climate change. In general, two main approaches are proposed to tackle this global issue: "Mitigation" and "Adaptation", each targeting different temporal, spatial, and sectoral scales. The mitigation approach focuses on the causes of climate change, namely the production and accumulation of greenhouse gases, whereas adaptation addresses managing and reducing the impacts of these changes [13–18].

Despite the distinction between these two approaches, integrating them in urban policy and planning is essential, as only the combination of mitigation and adaptation measures can prevent the exacerbation of long-term consequences while simultaneously enhancing the short-term resilience of cities [19–22]. From this perspective, effectively addressing climate change requires diverse responses at various spatial levels and must be pursued through coordinated policy interventions across all layers of spatial planning, from local to national, to both mitigate and adapt to these changes [23–27].

To date, most of humanity's responses to the consequences of climate change have been organized primarily at global and national levels through international agreements, decision-making tools, and mitigation and adaptation policies. However, studies have shown that many of these policies and actions are not very effective or appropriate when addressing climate issues that occur at a local scale and are directly experienced by citizens [5,12,28]. One of the most important tools available to urban managers for practically addressing diverse urban challenges and issues is the local development plan [8,12,27,29].

Therefore, it can be argued that despite the expansion of theoretical and empirical literature on climate change, mitigation, and adaptation,

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and the growing emphasis on the necessity of integrating these two approaches into urban planning, a significant research gap persists at the level of implementation and the local scale. The majority of existing studies and policy frameworks remain concentrated on global and national levels, paying limited attention to how, and to what extent, these strategies are reflected in local development plans and translated into context-specific and actionable measures. In particular, there is a paucity of empirical evidence regarding the simultaneous integration of mitigation and adaptation approaches within urban development plans, their effectiveness in addressing locally experienced climate risks, and the institutional and planning mechanisms that shape this process in cities of developing countries. Accordingly, conducting a systematic investigation into the role, content, and performance of local development plans in responding to climate change can help address this knowledge gap and clarify the link between macro-level climate policies and on-the-ground actions at the city and neighborhood scales.

As a result, focusing on local development plans as the core of this research constitutes a rational response to the existing gap between macro-level climate policies and the tangible realities experienced at the city and neighborhood scales. Given that the impacts of climate change manifest in heterogeneous ways and are highly contingent upon the social, economic, and physical contexts of specific places, local development plans possess the capacity to deliver context-sensitive, flexible, and actionable solutions grounded in a detailed understanding of local conditions and the participation of local stakeholders. The examination and analysis of such plans not only enable an assessment of the actual effectiveness of climate-related actions but also contribute to the production of applied knowledge that can strengthen the role of urban governance in effectively addressing climate challenges and enhancing local resilience.

Iran, as a developing country located on the Earth's dry belt, is structurally confronted with aridity and drought– two climatic characteristics that cannot be ignored [30,31]. Recent developments in the climate and water resources sector, including the drying of Lake Urmia and its consequences, decreased rainfall, recurring droughts, reduced river runoff, and widespread land subsidence, have clearly highlighted this reality. An analysis of hydrological cycle trends in Iran shows that, on average, since 1999 (1378 in the Iranian calendar), following a prolonged drought, the volume of surface flows and the amount of precipitation have decreased in many areas. This trend may be influenced by climate change and other climatic fluctuations in Iran [30,32,33].

The Isfahan metropolitan city is no exception; the continued prosperity of this historic city has always been closely linked to the Zayandehrud River. In recent years, alongside the drying of this river, drought and water scarcity, land subsidence, air pollution, and intensified dust storms have become the most significant current and potential natural hazards facing the city – hazards that are clearly connected to climate change [30,31,33]. As a result, the selection of the Isfahan metropolitan city as a case study for this research is grounded in its distinctive position at the intersection of climatic, environmental, and urban development challenges in Iran. As a historical metropolitan city located within the country's arid and semi-arid zones, the Isfahan metropolitan city simultaneously faces the consequences of declining water resources, persistent droughts, reduced surface water flows, land subsidence, and the intensification of environmental hazards—issues that are directly linked to climate change and significantly affect the city's livability and sustainability. The city's historical and functional dependence on the Zayandehroud River, together with its vulnerability to disruptions in the hydrological cycle, renders the Isfahan metropolitan city a representative and critical case for examining how urban development plans and policies respond to the impacts of climate change. Accordingly, studying the Isfahan metropolitan city provides an appropriate context for an in-depth analysis of climate-related challenges at the local scale and for generating findings that not only advance scientific understanding but also offer insights transferable to other cities facing similar climatic conditions.

Local development plans serve as the primary policy framework for shaping the social, economic, and physical development of cities. Interactions between these dimensions and the urban environment can significantly intensify or mitigate climate issues at various scales. Accordingly, this study systematically examines how local development plans explicitly and implicitly address climate-related themes.

In particular, it is necessary to obtain a comprehensive overview of the frequency and types of strategies and policies related to addressing this major challenge in local development documents. In this context, conducting a comprehensive study using qualitative-analytical methods can first identify and explain the key reflected themes, the network of relationships among them, and the trend of reliance on each of the two approaches – adaptation and mitigation – in the local development plans (past, present, and future) of the Isfahan metropolitan city. Then, based on the results of this qualitative analysis, existing gaps and shortcomings in policymaking can be identified, and recommendations can be made to enhance the effectiveness and improve these policies. Thus, the main question is, "What hidden and explicit climate themes are expressed in the development plans (past, present, and future) of the Isfahan metropolitan city to address climate change?" Additionally, the sub-questions of this research include:

- How much attention and use has each approach to addressing climate change (adaptation and mitigation) received in the local development plans of the Isfahan metropolitan city?
- In the thematic network derived from the analysis of these local development plans, what is the nature of cohesion, continuity, and comprehensive compatibility between the implicit and explicit climate-related themes?
- Based on the findings from the analysis, what gaps and shortcomings exist in climate policy within the local development plans of the Isfahan metropolitan city?

To advance this research, the stages of integrative reading and "reflexive-network" thematic analysis have been defined in seven main steps. In the final step, the study interprets the results from the analysis and explains the trend and extent of the use of each approach to addressing the challenges of climate change in each of the urban and regional development plans of the Isfahan metropolitan city, considering the time period (past, present, future) in which each plan was developed. As a result, the adoption of an integrated "reflective–network" analytical method in this study constitutes a methodologically grounded response to the multidimensional and interwoven nature of local development plans and their role in addressing climate change challenges.

Since climate-related themes within these documents are reflected not only explicitly but also implicitly and in a fragmented manner across physical, social, and economic policies, strategies, and regulatory provisions, the application of purely descriptive or single-dimensional approaches is insufficient to reveal underlying patterns and structural relationships. Reflective analysis enables the systematic identification of the type, frequency, and orientation of themes associated with mitigation and adaptation, while the network dimension of the method elucidates the interconnections and relational structures among these themes, thereby clarifying how different dimensions of local development plans interact with climate-related issues. Accordingly, the integrated "reflective–network" approach not only provides a comprehensive and multi-level understanding of the position of climate change within local development plans, but also facilitates the comparison of trends across different time periods and the identification of policy gaps and shortcomings—an essential basis for formulating evidence-based recommendations aimed at enhancing the effectiveness of urban planning in responding to climate change.

2. Theoretical foundations

2.1. Approaches to addressing climate change in urban areas

Historically, cities have concentrated near major water resources, a pattern that continues today, resulting in higher population densities around inland and coastal ecosystems. Consequently, many climate-related hazards manifest as urban risks, which are projected to increase in intensity and frequency with ongoing climate change [5,22,34–37]. Efficient urban planning can reduce vulnerability by guiding population and activities to lower-risk areas, emphasizing the critical role of cities—where more than half of the global population resides—in climate action [22,36–40]. Urbanization offers opportunities to develop mitigation and adaptation strategies through planning and good governance, highlighting the longstanding importance of environmental sustainability in urban planning. Since the IPCC's Fourth Assessment Report (2007), there has been growing focus on integrating mitigation and adaptation in urban contexts, but such measures must be tailored to local resources, capacities, and specific regional conditions [34,36,41–45].

2.1.1. The mitigation approach

The "mitigation" approach refers to a set of actions that reduce the contribution and role of humans in intensifying the greenhouse effect on a planetary scale [14,17,18,46]. These actions include enhancing processes that remove carbon dioxide from the atmosphere, as well as replacing conventional fossil fuel-based technologies and systems – which have high levels of carbon emissions – with low-carbon or carbon-free energy systems [17,18].

Researchers identify five main areas in which mitigation actions are relevant in urban environments: 1) the pattern, physical form, and structure of the city; 2) the built environment (buildings and human-made spaces); 3) urban infrastructure; 4) transportation systems and networks; and 5) the carbon sequestration capacity within the city and its surroundings [15,17,19,20,22]. It is noteworthy that, because the Earth's climate system inherently involves inertia and slow responses, mitigation efforts will only be effective if they are pursued and sustained over long periods.

2.1.2. The adaptation approach

Adapting to climate change requires a collective, multidimensional, and coordinated approach. In this context, local plans and spatial planning play a central role and provide the primary platform for action [8,14,17,18]. In the scientific literature, adaptation refers to how humans or natural systems adjust and regulate in response to actual or anticipated climatic stimuli and their effects. These adjustments reduce damages and allow stakeholders to utilize positive opportunities arising from these changes [35,47–49]. Accordingly, climate adaptation is a process through which local communities acquire the capacity and readiness to face the changing climate of the future [15,19,20,50].

Researchers identify four fundamental pillars in planning for climate adaptation: 1) strengthening the adaptive capacity of planning organizations and stakeholders by enhancing awareness, knowledge, skills, and access to resources; 2) managing and responding to the socio-economic consequences of climate change; 3) expanding platforms for participation and collaboration among stakeholders at various urban levels; and 4) integrating climate adaptation (and mitigation of its effects) into current urban plans, policies, programs, and planning processes [47–51].

In general, adaptation encompasses two-time scales: first, adaptation to current climate fluctuations, which may differ at each location from patterns recorded in historical data; and second, preparation for future long-term changes [19,20,46–49]. Accordingly, climate change adaptation involves actions aimed at reducing vulnerability to short-term climate shocks and enhancing resilience.

2.2. Mitigation and adaptation: Integrating two approaches

According to Table 1, given that the approaches of "mitigation" and "adaptation" differ in their goals and scale, they complement each other. Mitigation addresses the root causes of climate change by reducing emissions and the accumulation of greenhouse gases in the atmosphere, while adaptation focuses on coping with the actual and potential consequences and impacts of these changes. Therefore, adaptation is now considered an integral part of climate policy alongside mitigation [47,52,53]. Both approaches are necessary: even if mitigation policies succeed, climate change will continue in the coming decades, requiring communities to adapt; conversely, adaptation alone cannot eliminate all negative consequences, and without mitigation, the intensity and extent of changes will exceed manageable thresholds [15,17].

From a spatial perspective, policymakers usually set reduction targets at the global scale, while they establish adaptation targets primarily at local and regional levels [21,22]. These approaches also differ in temporal scale and their relation to various economic sectors; however, in practice, a flexible and long-term combination, tailored to local conditions and capacities, is considered the main strategy for effectively addressing climate change.

- In general, both approaches aim to reduce the risks and damages caused by climate change.
- Mitigation and adaptation both overlap in the agricultural and forestry sectors.

2.3. A narrative review of previous research

To clarify the importance of addressing the present study, previous similar research has been reviewed. This review focuses on the significant aspects of prior studies, such as their research objectives and results. The prioritization of the studies has been classified into three categories.

In the first category, research related to the evaluation of development plans from the perspective of assessing climate impacts, Kumar and Geneletti (2015) critically examined the integration of climate change issues into spatial plans in Indian cities and identified significant gaps and shortcomings [28]. The results of this study showed that the role of spatial planning in integrating climate change issues at the city level in India remains limited, and the overall performance of spatial plans has demonstrated low levels of awareness, moderate analytical capability, and limited responsiveness in incorporating climate change-related issues at the local level. Stevens and Senbel (2017), in a study based on research conducted in 2011 on plans in British Columbia, Canada, carried out a longitudinal study of these plans and examined their updated versions in 2015 [54]. One of the most important findings of this research is that overall, urban plans responding to climate change

Table 1
Similarities and differences between mitigation and adaptation.

Feature	Reduction	Adaptation
General concept	• Addresses the causes of climate change (accumulation of greenhouse gases in the atmosphere).	• Addresses the effects of climate change.
Spatial scale	• Primarily an international issue, as the reduction aims to achieve global goals.	• Essentially, a local issue, as adaptation primarily provides goals at the local and regional levels.
Temporal scale	• Reduction has a long-term effect due to the inertia of the climate system (long-term).	• Adaptation can have a short-term impact on reducing vulnerability (both short and long term).
Sections	• Reduction is a priority in the energy, transportation, industry, and waste management sectors.	• Adaptation is a priority in urban planning, water, health, and coastal sectors.

remained largely unchanged from 2011 to 2015, indicating that planners still have room for improvement. However, municipalities have so far focused more on mitigating the effects of climate change than on adapting to it.

Buzási and colleagues (2021), in an article, aimed to develop a method and comprehensive evaluation framework to address mitigation, adaptation, and awareness-raising aspects, to assess the potential impacts of interventions and urban development actions at a microscale on climate change [5]. One of the most important findings of the study is that development programs must directly contribute to climate change mitigation. Development plans should adopt a comprehensive evaluation approach to prevent negative outcomes during urban development activities.

Reckien and colleagues (2023), in a study aimed at defining and measuring progress in adaptation, raised important questions for the science, policy, and practice of climate adaptation [55]. One of the most significant findings is that half of the cities have adaptation plans, and the quality of these plans has improved significantly over time. However, the overall quality of the plans remains low in many cities. Tehler and colleagues (2024), in an article, demonstrate that many risk and resilience assessment methods lack sufficient supporting evidence, and methodological gaps must be filled for evidence-based local policy-making [56].

In the second category, research focuses on examining the climatic effects in cities. Kumar and colleagues (2016) present a method for spatial assessment of vulnerability to climate change within the process of spatial planning at the urban scale [27]. They propose an advanced methodological framework to guide policymakers and policy analysts in defining, visualizing, and analyzing vulnerability to reduce risks associated with changing climatic conditions. This framework was tested in a case study in a developing country. The results of the vulnerability assessment show that the northern, eastern, and southern areas of Bangalore are highly vulnerable to the impacts of climate change. The assessment also identifies key sensitive sectors that require immediate attention and integration into local policies in Bangalore, which can be achieved through spatial planning policies. Bin Ye (2021) conducted a study providing a critical review of recent research on climate change risk assessment at the urban scale [12]. This study identifies the main advancements and challenges in the current literature regarding climate change risk assessment at the urban level. It finds that existing research can be categorized into four main types: downscaling climate change from large to local scales, simulating urban development and microclimate, assessing urban climate change vulnerability, and integrated assessment.

In the third category, which covers research on frameworks and management actions in response to climate change, Thoidou (2021) examined issues related to land conservation and climate change in a suburban area of the Thessaloniki urban region in Greece, identifying how different types of spatial planning contribute to land conservation [57]. The results of this study revealed a dual challenge in achieving land conservation through spatial planning from the perspective of climate adaptation. The first challenge is the need for an integrated approach to land, requiring the incorporation of climate change risk assessment into all types and levels of spatial planning to make use of information at various levels. The second challenge is the need to translate public concerns into specific land development and conservation options that can be pursued through land use planning.

Adams and colleagues (2023), in a systematic review of 147 articles, presented a framework for the "mainstreaming of nature-based solutions" in cities, outlining the pathway for transforming adaptation concepts into urban planning and governance processes [58]. Bridges and colleagues (2024) emphasized the role of "climate knowledge exchange" in advancing adaptive planning and demonstrated that cross-sectoral knowledge exchange mechanisms enhance local feasibility and acceptance [59].

Based on the theoretical foundations and the literature review presented, it is evident that urbanization and climate change have a complex and dual relationship. On one hand, the rapid pace of urbanization in developing countries makes managing climate risks more challenging; on the other, this process can create new opportunities for sustainable development, social justice, and improved urban governance.

The two main approaches to climate change – mitigation and adaptation – have distinct functions and objectives, but ultimately must be applied within an integrated and complementary framework. Mitigation primarily addresses the causes of climate change (greenhouse gas emissions), while adaptation focuses on its effects. However, without combining these approaches, it is not possible to prevent long-term consequences or reduce the short-term vulnerability of urban communities.

A review of previous research indicates that, although positive steps have been taken in many countries to integrate climate considerations into local development plans and spatial planning, significant gaps remain in the quality, comprehensiveness, and implementation of these plans. Recent studies highlight the necessity of integrated approaches, evidence-based assessments, mainstreaming nature-based solutions, and mechanisms for exchanging climate knowledge. Therefore, based on the review in the literature section, no research to date has addressed the objectives of this study using an integrative reading with a "reflexive-network" analysis of themes to quantitatively and qualitatively analyze the content of urban and regional development plans in a sample of developing countries. This highlights one of the innovative aspects of this research.

3. Research methodology

3.1. Study background and introduction of selected development plans

Iran is located on the "Earth's dry belt", and drought is an undeniable aspect of the country's climatic conditions [30,31,33]. The Isfahan metropolitan city, the third-largest city, is situated in central Iran [60,61] (Fig. 1). Isfahan Province, with an area of 106,179 km^2, accounts for about 6.25% of the total area of Iran. The population of this city is estimated to be 2,109,654 in the year 1404 (2025–2026). Drought, water resource shortages, land subsidence, and air pollution caused by dust are among the most significant natural hazards in Isfahan Province, all of which result from climate change.

Studies indicate that, in terms of drought intensity and frequency, the western, south-western, and eastern regions of the province show greater sensitivity and vulnerability compared to other areas [30,31,33,62]. The average annual rainfall in Isfahan Province is 130 mm. This amount is less than half the national average and one-sixth of the global average. The potential evapotranspiration in the region is 3200 mm per year [32,60,61,63]. Analysis of the SPEI (Standardized Precipitation Evaporation Index) over 10 years up to the end of Aban 1401 (November 2022) indicates that mild to very severe long-term (hydrological) drought conditions exist in many areas of Isfahan Province. Specifically, 96.26% of the province's area is affected by drought, of which 4.43% is mild, 11.23% moderate, 55.70% severe, and 24.92% very severe drought. Meanwhile, only 3.36% of the province's area experienced normal conditions, and 0.38% experienced weak to moderate wet conditions [30,33,60,61,64].

Isfahan province is located adjacent to vast desert and arid regions. These areas, due to decreased soil moisture, vegetation degradation, and erosion of surface layers, are prone to soil particle uplift and the formation of dust phenomena. Such conditions are primarily the result of reduced soil and air moisture and declining groundwater levels, which are exacerbated by climate change [60,61]. In contrast, in the Isfahan metropolitan city, 13% of emitted pollutants originate from urban industries, 11% from household sources, and 76% are related to urban transportation. These figures highlight urban transportation as a critical factor in the city's severe air pollution [60,61,63,65].

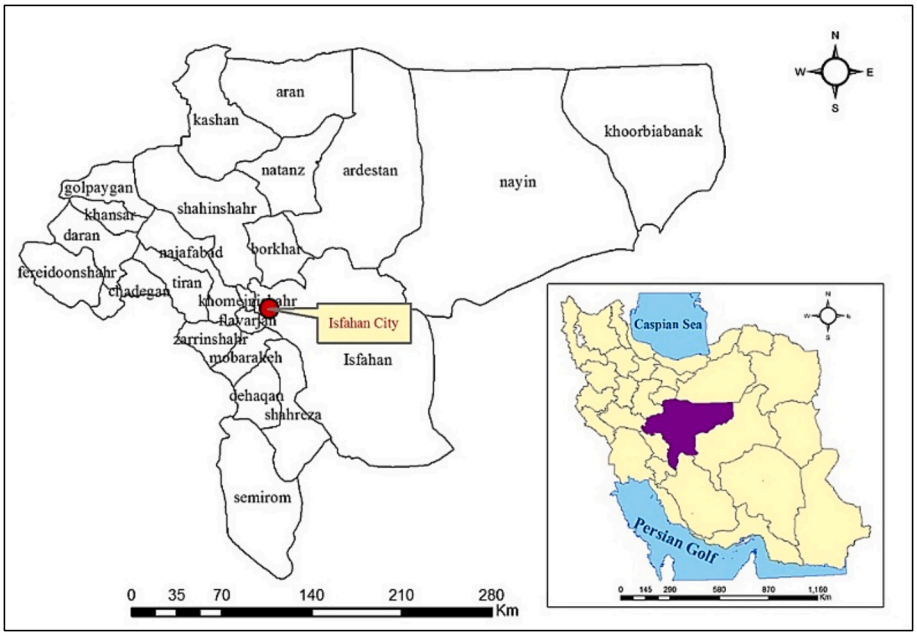

Fig. 1. Location of the Isfahan metropolitan city within the county, province, and country of Iran.

Land subsidence is considered one of the serious environmental challenges in Iran, posing a threat to the Isfahan metropolitan city and its surrounding areas, yet it has so far received little attention [30–33,60,61]. Studies show that the area affected by subsidence in Isfahan Province is approximately 2730 km^2, with subsidence rates reaching about 18 cm per year in this region. These areas include 170 villages and population centers. Consequently, global warming and the water crisis can be considered the most prominent manifestations of climate change in this country [30,32,33,60,61,63].

Nearly sixty years have passed since the drafting of the first modern urban development plan for the Isfahan metropolitan city. During this time, the Isfahan metropolitan city has undergone extensive environmental, economic, social, and physical transformations. In recent decades, urban and regional development plans have been designed and implemented as the main tools for planning and management, aiming to address urban and regional issues and challenges at the provincial, county, and metropolitan levels of Isfahan. In this research, seven selected plans developed for the city and the Isfahan metropolitan region since the late 2000s have been examined. Four are strategic urban development plans, and three are regional development documents for the city, covering three time periods (Table 2): the past five-year period (2010 to 2021), the current period (2021 to 2026), and proposed versions for the future (2026 to 2031).

Drawing on the theoretical literature in urban planning, institutional and procedural continuity within planning systems typically leads to the reproduction of dominant values and decision-making logics [66,67]. A substantial body of research further indicates that, without fundamental institutional transformation, future development documents tend to represent a normative and value-based extension of existing plans rather than a meaningful break from them [68,69].

In the Iranian context, numerous studies similarly emphasize that local development plans, despite periodic revisions, have exhibited structural inertia in their underlying value foundations and prevailing approaches; observed changes have been largely formal and physical [70,71]. Accordingly, given the continuity of the institutions responsible for preparing and approving local development plans – together with the absence of significant changes in drafting procedures, policy frameworks, and their underpinning value premises – no robust substantive distinction can be identified between current and prospective local development plans.

On this basis, it can be argued that, in the case of Isfahan, no material value-based differentiation between present and future local development plans is discernible, and their analytical and normative equivalence is supported by both theoretical and empirical evidence. In addition to their recency, criteria such as the comprehensiveness of the plans, the diversity of the institutions preparing or approving them, and the nature of their policymaking have been considered as the basis for selection. To clarify the explicit and implicit climatic themes in the development plans (past, present, and future) of the Isfahan metropolitan city for addressing climate change, the researchers took notes to reflect the theoretical foundations. At this stage, line-by-line documentation of the explicit and implicit codes in the development plans (initial coding) was completed. After multiple, active, and thorough readings, the data sources were coded, and the initial codes for each development plan were entered into the initial coding table.

Local development plans in the Isfahan metropolitan city lack coherence and continuity due to structural, institutional, and managerial factors. Political instability and frequent turnover of local officials tie plans to individuals rather than embedding them in stable governance, weakening policy continuity and long-term objectives. Limited autonomy and dependence on higher-level decisions, combined with short-term and unstable funding, further hinder effective implementation. Low community participation reduces local ownership and support, making plans vulnerable to administrative changes and crises. Finally, a project-based approach, focusing on short-term, isolated initiatives, fragments development actions and undermines alignment with long-term urban development goals.

3.2. Innovative-integrative reading of the Reflective-network analysis of themes

To examine the research objectives, an innovative and integrative approach was used, combining “reflexive-network” thematic analysis and both quantitative and qualitative content analysis of the data, employing MAXQDA software and the graphical tool draw.io for network mapping. To advance the research process, the stages of the integrative reading of the “reflexive-network” thematic analysis were defined in seven main steps. Based on the review conducted in the research background section, no previous study has been carried out with the stated objectives of this research, nor using the innovative and

Table 2
Introducing selected urban and regional development plans.

Scale	Title of the plan	Introducing development plans
Metropolitan Scale (Regional)	- Provincial Development Plan	- Provincial development plan aims to systematically assess natural, social, economic, cultural, and other factors to encourage and assist community stakeholders in selecting suitable options for enhancing and sustaining land capacity to meet society's needs.
	- Metropolitan area plan	- The inclination towards Metropolitan area plan in the administrative system of Iran entails the definition and delineation of the territories of Metropolitan areas and the preparation of development plans for extensive and interrelated territorial domains composed of overlapping layers of administrative systems and national divisions.
	- Strategic-structural, and operational management and development of resources, facilities, and infrastructures (Isfahan province comprehensive tourism plan)	- The concept of a comprehensive tourism plan entails organizing spatial behaviors of two levels of tourism activities (international and domestic) and harnessing the benefits of socio-cultural, economic, political, technological, environmental, and other dimensions.
Urban scale	- Isfahan Municipality's Fourth Five-Year Plan "Isfahan 95 with a Strategic Approach." - Isfahan Municipality's Fifth Five-Year Plan "Isfahan 1400 Strategic Plan." - Isfahan Municipality's Sixth Five-Year Plan "Isfahan 1405 Strategic-Operational Plan."	- In the urban renewal and development law of Iran, municipalities are obligated to prepare a five-year operational plan for urban renewal and improvements based on a comprehensive plan. The purpose of developing such plans is essentially long-term planning for the gradual implementation of comprehensive plans.

integrative "reflexive-network" thematic analysis method that aims to perform both quantitative and qualitative content analysis of urban and regional development plan data.

It should be noted that the purpose of coding and theme development in reflexive thematic analysis is neither to "accurately and correctly" summarize the data nor to minimize the researcher's subjectivity in the analysis process, as such a task is neither possible nor desirable. The aim is to provide a coherent and compelling interpretation of the data [72–77]. The researcher acts as the narrator, actively interpreting the data through lenses shaped by their social position, theoretical assumptions, ideological commitments, and specialized knowledge. This mindset – and the approach adopted in the research – is valued for its high flexibility within interpretive and critical paradigms [72–77].

In contrast, thematic network analysis aims to identify patterns and models in some studies [72,78–81]. In thematic networks, the analysis is organized as a network of basic, organizing, and global themes. The method of analysis in thematic networks is step-by-step, structured, and integrative. The structure of this analysis enables the researcher to transform raw data into a presentable conceptual pattern. This aligns with the pragmatist methodology [73,78,80,82–84] because it combines deductive and inductive procedures, as well as both structured and flexible analysis, depending on the research topic [78,79,81,85,86]. The researcher occupies an active analytical position; their role is not merely to extract data but also to structure meanings and determine the relationships between themes. The final organization of thematic networks should therefore be based on the central questions surrounding the research problem [73,78,80,82–84].

The integration of Braun and Clarke's reflexive thematic analysis with Attride-Stirling's thematic network analysis can thus provide a powerful combined framework for qualitative research in urban planning, city planning, and participatory design, as the former emphasizes a reflexive and in-depth understanding of experiences, while the latter focuses on mapping conceptual and discursive structures among themes [87–99].

It is important to note that in this study, several strategies were employed to enhance credibility and validity: using direct quotations from the designs to extract codes and clarify the explanation of themes; reviewing and evaluating the themes by a collaborating expert or an external specialist; and documenting the entire analysis process with relevant software to enable tracking and reproduction of the results. Reflexive analysis acknowledges the presence of subjectivity in the research process; however, potential bias was controlled and mitigated by systematically referring to established theoretical frameworks whenever ambiguities or analytical deviations arose. In such instances, the analysts and authors relied on relevant theoretical foundations to clarify interpretations and reorient the analysis, thereby enhancing the rigor and credibility of the Results. In Fig. 2, the key components of each stage of the integrated reading of the "reflexive-network" analysis of the proposed themes, along with the evaluation questions for each section, are comprehensively presented.

In the reflexive coding of data to uncover explicit and implicit themes related to climate change, the researchers consciously sought to control personal bias. The resulting codes were essentially descriptive, and the coding was conducted openly and inductively, without relying on a prior theoretical framework. In the next step, the codes were organized based on shared semantic patterns (Table 3). These shared semantic patterns served as the basis for extracting and explaining the core themes. Therefore, the frequency of each core theme in the various development plans was calculated based on the frequency of the initial codes. Each pattern was not necessarily present in all plans (either as an explicit or implicit code), but its appearance in even one plan was sufficient to define the pattern as a shared semantic concept. In this way, all explicit and implicit climate-related themes present in the selected urban and regional development plans of the Isfahan metropolitan city for addressing climate change were identified, and Chart 3 shows the frequency and intensity of these codes in each plan.

By analyzing the internal relationships and structure among the basic themes, organizing themes were developed. These organizing themes emerged from grouping the basic themes based on conceptual similarity, shared context, or functional climate. Using an interpretive approach, the researchers provided a definition, name, and corresponding "interpretive narrative" for each theme in line with the existing theoretical literature to clarify the meaning of each organizing theme within the framework of its basic themes. Then, by identifying a central or overarching theme under which other sub-themes fall, a holistic structure of climate narratives extracted from the projects was formed. In this study, three overarching themes – "adaptation approach", "mitigation approach", and "combination of the two approaches (adaptation and mitigation) [sustainability]" – were defined based on the organizing themes and linked to the theoretical framework and prior literature to shape the final narrative structure of the research.

4. Results and discussion

In response to the main research question, "What hidden and explicit climate themes are expressed in the development plans (past, present, and future) of the Isfahan metropolitan city to address climate change?",

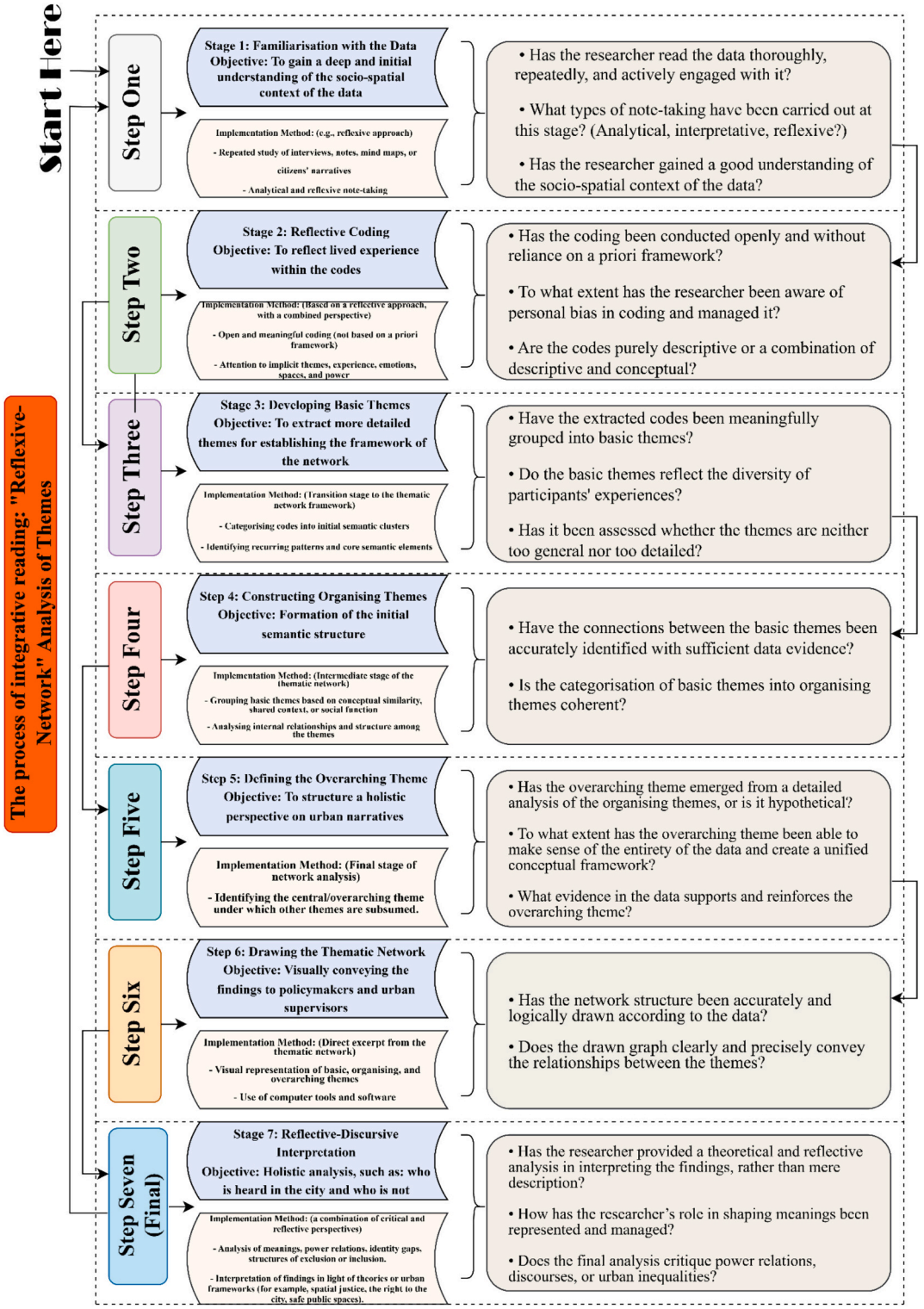
Start Here
The process of integrative reading: "Reflexive-Network" Analysis of Themes
Step One
Stage 1: Familiarisation with the Data
Objective: To gain a deep and initial understanding of the socio-spatial context of the data
Implementation Method: (e.g., reflexive approach)
- Repeated study of interviews, notes, mind maps, or citizens' narratives
- Analytical and reflexive note-taking
• Has the researcher read the data thoroughly, repeatedly, and actively engaged with it?
• What types of note-taking have been carried out at this stage? (Analytical, interpretative, reflexive?)
• Has the researcher gained a good understanding of the socio-spatial context of the data?
Step Two
Stage 2: Reflective Coding
Objective: To reflect lived experience within the codes
Implementation Method: (Based on a reflective approach, with a combined perspective)
- Open and meaningful coding (not based on a priori framework)
- Attention to implicit themes, experience, emotions, spaces, and power
• Has the coding been conducted openly and without reliance on a priori framework?
• To what extent has the researcher been aware of personal bias in coding and managed it?
• Are the codes purely descriptive or a combination of descriptive and conceptual?
Step Three
Stage 3: Developing Basic Themes
Objective: To extract more detailed themes for establishing the framework of the network
Implementation Method: (Transition stage to the thematic network framework)
- Categorising codes into initial semantic clusters
- Identifying recurring patterns and core semantic elements
• Have the extracted codes been meaningfully grouped into basic themes?
• Do the basic themes reflect the diversity of participants' experiences?
• Has it been assessed whether the themes are neither too general nor too detailed?
Step Four
Step 4: Constructing Organising Themes
Objective: Formation of the initial semantic structure
Implementation Method: (Intermediate stage of the thematic network)
- Grouping basic themes based on conceptual similarity, shared context, or social function
- Analysing internal relationships and structure among the themes
• Have the connections between the basic themes been accurately identified with sufficient data evidence?
• Is the categorisation of basic themes into organising themes coherent?
Step Five
Step 5: Defining the Overarching Theme
Objective: To structure a holistic perspective on urban narratives
Implementation Method: (Final stage of network analysis)
- Identifying the central/overarching theme under which other themes are subsumed.
• Has the overarching theme emerged from a detailed analysis of the organising themes, or is it hypothetical?
• To what extent has the overarching theme been able to make sense of the entirety of the data and create a unified conceptual framework?
• What evidence in the data supports and reinforces the overarching theme?
Step Six
Step 6: Drawing the Thematic Network
Objective: Visually conveying the findings to policymakers and urban supervisors
Implementation Method: (Direct excerpt from the thematic network)
- Visual representation of basic, organising, and overarching themes
- Use of computer tools and software
• Has the network structure been accurately and logically drawn according to the data?
• Does the drawn graph clearly and precisely convey the relationships between the themes?
Step Seven (Final)
Stage 7: Reflective-Discursive Interpretation
Objective: Holistic analysis, such as: who is heard in the city and who is not
Implementation Method: (a combination of critical and reflective perspectives)
- Analysis of meanings, power relations, identity gaps, structures of exclusion or inclusion.
- Interpretation of findings in light of theories or urban frameworks (for example, spatial justice, the right to the city, safe public spaces).
• Has the researcher provided a theoretical and reflective analysis in interpreting the findings, rather than mere description?
• How has the researcher's role in shaping meanings been represented and managed?
• Does the final analysis critique power relations, discourses, or urban inequalities?

Fig. 2. Proposed steps for conducting an integrative reading of the "reflexive-network" analysis of themes in urban studies and planning.

the researchers conducted memoing with the aim of reflecting theoretical underpinnings, this stage resulted in the line-by-line documentation of explicit and implicit codes from the urban and regional development plans of Isfahan city and its metropolitan area (initial coding). After multiple, active, and thorough readings, the data sources were coded, and the initial codes for each development plan were placed in the initial coding table. The presence of explicit and implicit codes for a semantic pattern in just one plan was sufficient for its formation, allowing for the subsequent search for its explicit and implicit codes in other plans. This approach enables the identification of all explicit and implicit climate themes present in the selected urban and regional development plans of Isfahan metropolitan city for addressing climate change. To better understand the intensity with which explicit and implicit codes of each of these foundational themes appeared in each plan, Fig. 3 was generated.

As shown in Fig. 3, among the foundational explanatory themes, the highest frequencies are found in "transit-oriented development",

Table 3
Categorization of organizing themes for urban and regional development plans of the Isfahan metropolitan city into overarching themes, under the central theme of "approaches to addressing climate change".

Common semantic patterns	Basic themes	Organizing themes	Definition of each organizing theme	Overarching themes	A brief definition of overarching themes
Developing concepts to raise awareness about the process of global warming.	Development of climate change knowledge	Knowledge development and urban Planning	Although human awareness of climate change and its effects on life dates back as far as human existence on Earth, never before has humanity been as conscious as it is today of the importance of understanding the impacts of climate change on its activities. This subject seeks to develop the concepts of climate change and/or global warming, predict their effects, and explain guidelines aimed at raising awareness about the warming of the Earth and the occurrence of climate change impacts. Nowadays, extreme events caused by climate change have surpassed the danger threshold, resulting in potential and critical climate disasters.	Adaptation	Adaptation refers to adjustments in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderate harm or exploit beneficial opportunities. In fact, adaptation addresses two-time scales: 1) adapting to current variability at any specific location, and 2) preparing for future changes.
Predicting the effects and risks of climate change on the environmental, social, and economic fabric of the region.	Prediction of climate change effects				
Vision planning and setting objectives to alter the level of greenhouse gas emissions and influence the course of climate change.	Outlook and objectives for combating climate change				
Guidelines and operational standards for adaptation and mitigation measures in the field of urban planning and climate change.	Guidelines and standards for addressing climate change				
Raising awareness and providing education for active participation in climate-related issues.	Climate change awareness-raising				
Assessment of the vulnerability of ecosystems, food security, settlements and communities, water resources, and human health.	Vulnerability assessment	Urban planning and economics	For the planning of economic sectors, it is necessary to conduct an accurate assessment of the probable extent of vulnerability resulting from climate change. The importance of understanding the level of urban vulnerability and the capacity to adapt to climatic effects can be analyzed at least on two distinct levels: from the perspective of the city as a whole and the manner in which it develops, and from the perspective of the city broken down to reveal the access of different social and demographic groups to the determinants of adaptive capacity.		
Planning policies and land use design to limit energy consumption in expanding urban areas, informal settlements, or suburban development.	Physical growth assessment				
Evaluation of regional economic growth, employment structure, and livelihoods.	Economic assessment				
Water-sensitive urban design (permeable surfaces, drainage channels, etc.), development of efficient and new infrastructure.	Prioritization of key actions for implementation				
Alignment of important and necessary decisions with existing and potential impacts and risks.	Evaluation and updating of information				
Implementation of strategy (avoidance, transfer, enhancement) in the urban transport sector.	Alternative transport strategies	Transportation	In order to address existing challenges and create efficient transportation, the United Nations Environment Program's transport sector has proposed strategies based on the principles of sustainable development. The aim of this approach is to significantly reduce greenhouse gas emissions, decrease energy consumption, lessen traffic congestion, and ultimately create livable cities.		
Management of transport demand and parking demand.	Transit-oriented development				
Measures aimed at increasing demand for alternative modes of travel (such as public transport, walking, and cycling).	Development of clean transport				
Classification of types and sources of greenhouse gas emissions.	Sources of greenhouse gas emissions	Resource management and carbon sequestration	Most urban carbon sequestration projects involve tree planting and the restoration and preservation of existing carbon sinks. It is important that these projects simultaneously provide carbon sequestration functions while also protecting water and soil resources, which are crucial both for cities' adaptation to the potential impacts of climate change and specifically related to climate change mitigation goals.	Mitigation	Mitigation refers to actions aimed at reducing the amount and rate of future climate change by decreasing greenhouse gas emissions or enhancing their removal from the atmosphere.
Assessment of drivers, sources, or main factors of climate change, as well as evaluation of the potential impacts of climate change on the planning area.	Assessment of climate change impacts on natural areas				
Preservation and enhancement of areas that serve as carbon sinks in the city (forests, green belts, protection of natural habitats, etc.).	Urban carbon capture and storage				
Watershed-based and ecosystem-oriented land management.	Natural land management				

(*continued on next page*)

Table 3 (*continued*)

Common semantic patterns	Basic themes	Organizing themes	Definition of each organizing theme	Overarching themes	A brief definition of overarching themes
Assessment of landscaping inventory with plants, Assessment of urban forests, parks, and open spaces, natural drainage systems.	Assessment of green infrastructure	Land use and the built environment	Not only do climate changes affect land use changes, but land surface use changes also have a reciprocal impact on environmental and climatic changes at the land surface. The sustainability of natural resources is directly and/or indirectly related to the surface cover of lands in different regions.	Both adaptation and mitigation approaches	Since both approaches aim to reduce the risks arising from climate change and its related damages, a combination of both mitigation and adaptation approaches is often used in some responses to climate change.
Assessment of housing inventory and land use changes required in plans and programs.	Evaluation of land use change				
Policy of controlling or limiting urban growth to manage urban sprawl and uneven city expansion.	Control of service delivery boundaries				
Implementation of land use planning and design policies to restrict energy consumption in new urban areas.	Creation of resilient land uses				
Higher concentration of people and activities, economies of scale.	Diversity and mixing of uses				
Urban development in old industrial areas or other neglected parts of the city to encourage density, mixed-use development, and reduce energy consumption in the city.	Smart growth and inward development				
Assessment of demand and supply levels for energy and water consumption.	Assessment of energy demand and supply	Urban infrastructure	Many urban infrastructure initiatives focusing on energy efficiency are primarily driven by factors such as the desire for energy security and financial savings, and to a lesser extent by the opportunities offered by international instruments. However, today it is important that energy efficiency projects not only develop low-carbon renewable resources but also place emphasis on efforts to manage consumption reduction through technologies for energy resource recovery.		
Evaluation of the water and sewage situation in relation to existing climatic conditions and issues.	Evaluation of energy efficiency				
Development of renewable and clean energy or low-carbon energy supply systems at the city scale.	Renewable energies				
Methods of waste utilization to reduce gases produced at landfill sites.	Waste management technologies				
Recycling and treatment/ management of sewage and water demand management.	Wastewater control and treatment				
Updating drought management programs to understand changing conditions.	Enhancing preparedness for drought				

"alternative transportation strategies", "economic evaluation", and "energy efficiency assessment". In the Isfahan metropolitan city, a prominent example of cities in developing countries, attention to sustainable transportation, energy, and water efficiency, and regional economic evaluation is a fundamental necessity in local development plans. Rapid population growth and increased car ownership in this city have caused the transportation sector to play a significant role in air pollution, traffic congestion, and greenhouse gas emissions. In these circumstances, implementing "Avoid, Shift, and Improve" (ASI) strategies and developing transit-oriented development (TOD) are key approaches to reducing excessive reliance on cars, improving environmental quality, and strengthening urban vitality.

The concept of "transit-oriented development" in these plans aims to coordinate major urban land uses (educational, healthcare, recreational, etc.) with transportation policies, which can reduce travel costs and traffic congestion in metropolitan areas. Therefore, the approach of urban development based on public transportation (TOD) has emerged in this context, aiming to reduce car dependency and enhance the sustainability and vitality of cities [100–102]. However, in the context of alternative transportation strategies, and considering the United Nations Environment Programme's approach to addressing traffic problems, three strategies– avoidance, shift, and improvement– are pursued in these development plans. Avoid: reducing the need for travel through the integration of land use and transportation, the development of dense settlements, and the use of communication technologies. Shift: changing travel patterns towards public and non-motorised transportation (walking, cycling) instead of private cars, along with investment in related infrastructure. Improve: increasing energy efficiency and vehicle technology by using clean vehicles (electric, hybrid, biofuels, and hydrogen) and optimising infrastructure.

These three approaches should be applied according to the conditions and problems of each region to achieve reductions in greenhouse gas emissions, energy savings, traffic reduction, and the creation of liveable cities [103–105].

On the other hand, the high intensity of energy consumption in Iranian cities, which is several times the global average, together with the finite nature of oil and gas resources, has greatly increased the importance of energy-saving policies and improving energy efficiency. Reforming consumption patterns across all sectors and adopting modern technologies can simultaneously reduce costs and strengthen the economic resilience of cities against climate change, which is the focus of the "Energy Efficiency Assessment". The water crisis in the Zayandeh Rud basin is also regarded as one of the most significant environmental and social threats to the Isfahan metropolitan city, with far-reaching consequences for agriculture, industry, and the social life of the city. Therefore, integrated water resource management, increased consumption efficiency, and prevention of new loadings in this basin are essential prerequisites for achieving sustainable urban development

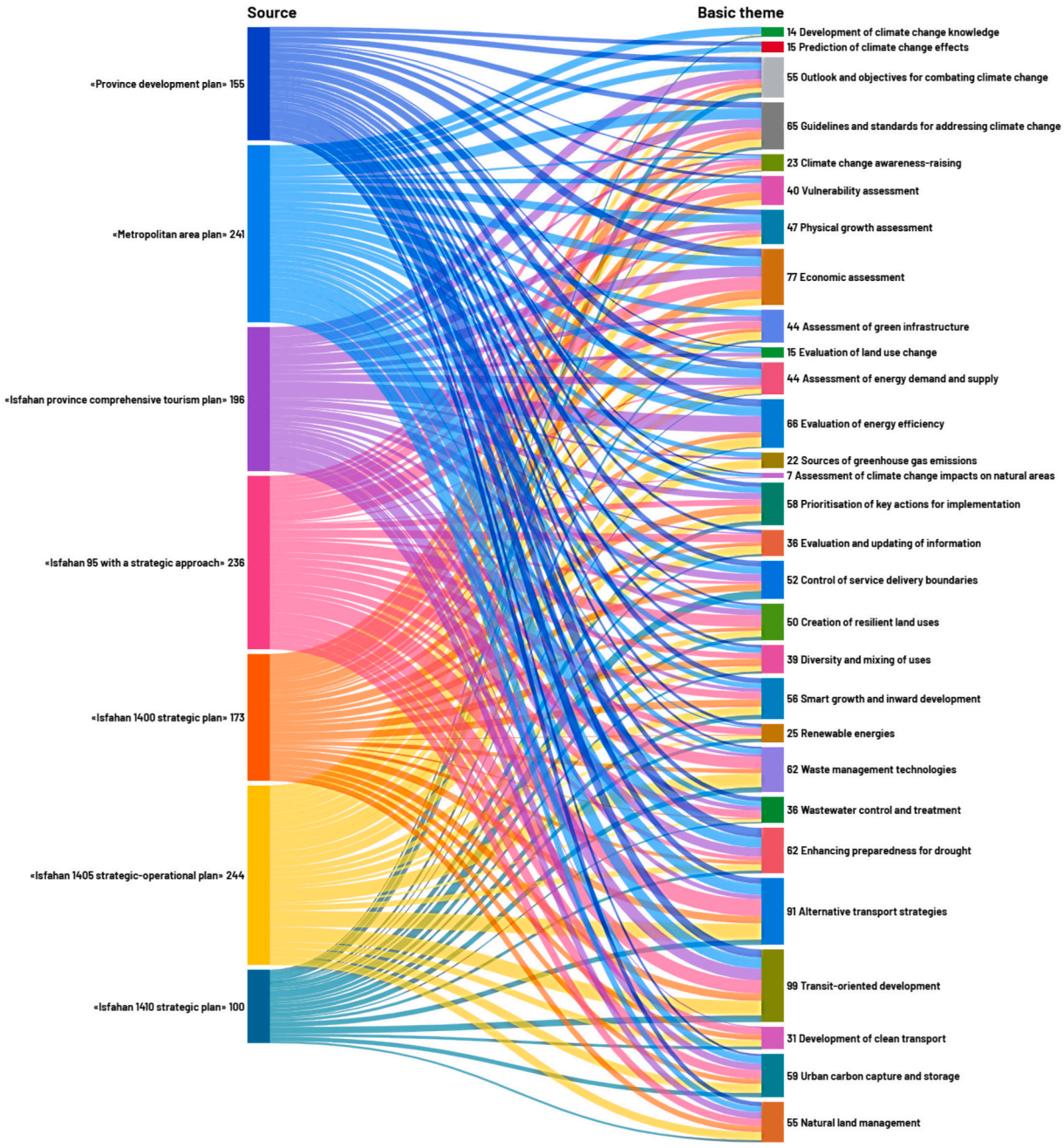
Source
Basic theme
«Province development plan» 155
«Metropolitan area plan» 241
«Isfahan province comprehensive tourism plan» 196
«Isfahan 95 with a strategic approach» 236
«Isfahan 1400 strategic plan» 173
«Isfahan 1405 strategic-operational plan» 244
«Isfahan 1410 strategic plan» 100
14 Development of climate change knowledge
15 Prediction of climate change effects
55 Outlook and objectives for combating climate change
65 Guidelines and standards for addressing climate change
23 Climate change awareness-raising
40 Vulnerability assessment
47 Physical growth assessment
77 Economic assessment
44 Assessment of green infrastructure
15 Evaluation of land use change
44 Assessment of energy demand and supply
66 Evaluation of energy efficiency
22 Sources of greenhouse gas emissions
7 Assessment of climate change impacts on natural areas
58 Prioritisation of key actions for implementation
36 Evaluation and updating of information
52 Control of service delivery boundaries
50 Creation of resilient land uses
39 Diversity and mixing of uses
56 Smart growth and inward development
25 Renewable energies
62 Waste management technologies
36 Wastewater control and treatment
62 Enhancing preparedness for drought
91 Alternative transport strategies
99 Transit-oriented development
31 Development of clean transport
59 Urban carbon capture and storage
55 Natural land management

Fig. 3. Frequency intensity of each core theme in each of these urban and regional development plans of the Isfahan metropolitan city.

[106–108].

Moreover, the macroeconomic dependence of the Isfahan metropolitan city on sectors such as industry, agriculture, and tourism has resulted in climate change having significant direct and indirect effects on employment and the livelihoods of its citizens. Therefore, the theme of "economic assessment", aimed at understanding the relationship between climate change and the structure of employment, livelihood security, and quality of life, is essential for designing adaptation policies and reducing social vulnerability [35,109–111].

Based on this, it can be concluded that focusing on these themes in the development plans of the Isfahan metropolitan city is not merely a choice but a strategic necessity for achieving climate resilience, economic sustainability, and improving urban quality of life in the face of future climate changes.

However, the lowest frequency is found in fundamental themes such as "assessment of the impacts of climate change on natural areas", "development of climate change knowledge", "prediction of climate change effects", and "land use change assessment". Therefore, it can be said that in local development plans, while some themes have been addressed thoroughly and seriously, others have only been mentioned briefly. This relative neglect of the fundamental themes presented can be attributed to the interplay of several structural, institutional, and technical factors.

First, the logic of urban and regional planning in the metropolises of developing countries is often project-oriented and short-term; resource allocation favours tangible, quick-yield projects, while knowledge development and forecasting-driven themes, whose outcomes are medium- to long-term, remain marginalized in budget competition. Second, the dispersion of governance and the scale gap between urban, provincial, and national institutions – especially on cross-scale issues such as climate and biodiversity – mean that direct responsibility for monitoring and forecasting climate impacts or managing land-use

changes becomes lost among agencies, weakening enforcement guarantees.

Third, data and technical shortcomings, such as the lack of integrated remote sensing systems and the shortage of fine-scale climate data, result in weaknesses in scenario development and urban climate services. Therefore, while development plans have addressed the essential existence of some fundamental themes, there has not been serious or sustained attention to their further and better expansion.

According to Table 3, the overarching themes are divided into three categories: "Adaptation Approach", "Mitigation Approach", and "Integration of Adaptation and Mitigation Approaches". To better understand the level of attention and use of each approach to addressing climate change across all development plans (past, present, and future) for the Isfahan metropolitan city, it can be stated that, by aggregating the frequency of organizing themes within the three overarching themes, the share of the adaptation theme from the combined two organizing themes of "Urban Planning and Economics" and "Knowledge Development and Urban Planning" amounts to 32.25% of the total. Adaptation depends on tools for formulating strategies and policies to address short-term climate changes, a risk monitoring system, and the gradual alignment of investments. Strengthening knowledge capacity enables faster and more targeted decision-making. Its connection with the urban economy mobilises climate-compatible financial resources. This combination paves the way for the gradual implementation of projects resilient to heat and water scarcity.

The combined organizing themes of "transportation" and "resource management and carbon sequestration" account for 25.65% of the total reduction. The organizing theme of "carbon sequestration" follows consumption reduction management policies through energy resource recycling technologies. Although the organizing theme of transportation has the highest percentage, it has not yet reached a transformative level.

To align with regional and urban goals, decisive emission reduction policies are needed. These policies should focus on fleet electrification, travel demand management, energy retrofitting in buildings, and renewable power generation.

The largest share is attributed to the integrative approach, which combines the organizing themes of "land use and the built environment" and "urban infrastructure", covering a total of 42.08%. One of the main advantages of the integrative approach in the development plans for the Isfahan metropolitan city is that it both increases resilience and reduces carbon emissions. The compact arrangement of land uses and the integration of work, residence, and services reduce travel time and distance. In addition, green-blue networks and infrastructure, and their redesign, enhance the city's resilience to heat and drought, and consequently to the subsidence resulting from these conditions. These simultaneous measures also reduce energy consumption.

As a result, development plans have gradually shifted over time towards synergistic interventions in land and infrastructure. The adaptation approach has also matured and established its role within the policymaking cycle. However, the mitigation approach has yet to progress in an integrated and mandatory manner and remains largely at the level of isolated projects. Considering the overarching network of themes in local development plans (Fig. 5), all these comprehensive themes can be interpreted under the central theme of "Approaches to Addressing Climate Change".

Therefore, considering Fig. 4, which shows the percentage frequency of hidden and explicit climate codes among urban development plans, it can be stated that "Isfahan 95 with a strategic approach", as one of the previous development plans, has the highest frequency of climate codes among the development plans. In second place, with a slight difference, is the "Isfahan 1405 Strategic-Operational Plan", which is one of the current period's plans. It is worth noting that these two are urban plans, and among regional plans, only the "Metropolitan area plan", as one of the previous development plans, can be mentioned in third place among development plans. A notable point is the lack of special and serious attention to climate change approaches in future development plans, as the lowest percentage of both hidden and explicit climate-related codes among urban development plans belongs to the "Isfahan 1410 Strategic Plan", which has a frequency of less than 10%.

This downward trend in the "Isfahan 1410 Strategic Plan" reflects a marginalization of climate change within the urban planning process, which can be analyzed from various perspectives. Economically, in the local development Plans of developing countries, the focus of local policymakers on short-term economic growth, rapid job creation, and the implementation of physical projects such as housing and transport infrastructure has led to climate issues, with their delayed and indirect returns not being prioritised [22,112,113]. In this metropolis, financial pressures and budget constraints on municipalities have further intensified this approach.

Additionally, in cities of developing countries, from a cultural and social perspective at both general and managerial levels, understanding of the consequences of climate change is weaker compared to more immediate and tangible issues, such as the water crisis, traffic, or housing shortages. As a result, climate change is often perceived as an abstract and long-term phenomenon that does not require immediate action. Therefore, it can be interpreted that in the development plans of the Isfahan metropolitan city, the lack of climate literacy and planning among the community and urban managers has resulted in the absence of social pressure or genuine demand for mainstreaming climate policies in development plans.

From an institutional and managerial perspective, the dispersion of responsibilities and lack of coordination among the responsible agencies mean that no organization seriously assumes responsibility for pursuing and integrating climate policies into local development documents. Thus, in the development plans of the Isfahan metropolitan city, given the cross-sectoral nature of climate change, existing structural weaknesses have prevented its effective integration into urban policies. It should also not be overlooked that future development plans are heavily influenced by overarching governance priorities. Since climate change has not yet been institutionalised as a central focus of policymaking at the national and local levels in the Isfahan metropolitan city, it is mostly addressed in new documents in a recommendatory or symbolic manner,

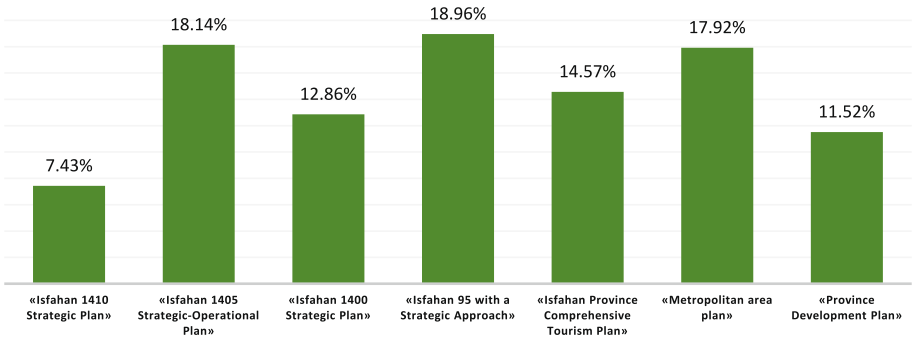

Fig. 4. The percentage and intensity of exposure of each of Isfahan's urban and regional development plans to hidden and explicit climate codes.

Approaches to addressing climate change
Adaptation and mitigation approach
Mitigation approach
Adaptation approach
Urban infrastructure
Land use and the built environment
Resource management and carbon sequestration
Transportation
Knowledge development and urban planning
Urban planning and economics
Sources of greenhouse gas emissions
Urban carbon capture and storage
Assessment of climate change impacts on natural areas
Natural land management
Transit oriented development
Development of clean transport
Alternative transport strategies
Enhancing preparedness for drought
Renewable energies
Waste management technologies
Evaluation of energy efficiency
Wastewater control and treatment
Assessment of energy demand and supply
Smart growth and inward development
Diversity and mixing of uses
Creation of resilient land uses
Control of service delivery boundaries
Assessment of green infrastructure
Evaluation of land use change
Climate change awareness-raising
Development of climate change knowledge
Prediction of climate change effects
Outlook and objectives for combating climate change
Guidelines and standards for addressing climate change
Vulnerability assessment
Physical growth assessment
Economic assessment
Evaluation and updating of information
Prioritisation of key actions for implementation

Fig. 5. Macro diagram of the hierarchy and network of basic, organizing, and overarching themes under the central theme "Approaches to Addressing Climate Change", derived from the "Reflective-Network" analysis of Isfahan urban and regional development plans in response to climate change.

rather than as a strategic requirement.

Therefore, it can be concluded that the declining attention to climate change in future local development plans for the Isfahan metropolitan city is primarily due to economic and sociocultural factors. Financial pressures, a focus on short-term efficiency, and the absence of a climate-conscious culture at both public and managerial levels have relegated this issue to a lower priority compared to other urban objectives. However, as this metropolis faces tangible climate crises such as the drying of the Zayandeh Rud River, land subsidence, and air pollution, continuing this approach can severely undermine urban resilience to climate change and widen the gap between environmental necessities and the trajectory of local development. Thus, although local development plans generally play an important role in adapting to or mitigating the effects of climate change, the cognitive information and policies specifically designed to address climate change still lack sufficient strength to effectively confront and fundamentally resolve the climate challenges that impede regional and urban development and management.

Based on the analysis findings, the existing gaps in climate policy for local development plans in the Isfahan metropolitan city are as follows: First, this metropolis has the lowest level of "development of carbon sequestration functions" at the local level. Without this development, the prioritization of ongoing or planned projects for the future lacks a climate-oriented perspective. Second, "knowledge development and urban planning" for advancing concepts related to climate change and global warming, forecasting impacts, and formulating guidelines to raise awareness about the Earth's warming trend and the occurrence of climate change effects is neither sufficient nor acceptable, and reliable data are not being produced. Third, policies for reducing consumption and optimising management in transportation have not progressed beyond the infrastructure level and do not hold an adequate position.

Therefore, addressing the urban climate outlook of the Isfahan metropolitan city as a hazard-centred issue – one causing severe impacts on the city's structure, such as serious or ongoing land subsidence – has not yet been incorporated into key strategies like a "water-sensitive city". These points indicate that the development plans for the Isfahan metropolitan city place strong emphasis on dual interventions in land and infrastructure, creating synergy between adaptation and mitigation approaches. However, governance capacity is increasingly able to address adaptation. The main gap lies in the lack of serious attention to mitigation goals, broader integration, and the shortage of decisive policies to confront climate change over the long term within these plans. To address or reduce the impact of these gaps, measures such as setting an urban carbon budget, revising building codes and land use regulations, accelerating fleet electrification, and institutionalising the financing of resource management and carbon sequestration can be taken. These actions aim to ensure full coherence of development plans and guarantee the comprehensive sustainability of the metropolis in the long term.

The findings from the thematic network analysis of development plans in the Isfahan metropolitan city indicate that although the integration of adaptation and mitigation approach accounts for 42.08% and

the adaptation approach accounts for 32.25% of the climate-related themes- representing the largest shares- the alarming point is that the mitigation approach, with 25.65%, has neither achieved integrated and mandatory progress nor advanced beyond the level of isolated projects.

On the other hand, the quantitative distribution of climate change themes in Fig. 3 reveals, beyond a mere numerical ranking, three structural paradoxes that clarify the hidden institutional logic of climate policymaking within the metropolitan development plans of the Isfahan metropolitan city. The first paradox is the dominance of demand management over foundational knowledge systems. The highest frequencies belong to themes of climate consequence management (transit-oriented development, economic evaluation, energy efficiency), whereas foundational themes such as climate knowledge development, impact prediction, and natural vulnerability assessment exhibit the lowest frequencies. This pattern reflects an institutional preference for aligning with conventional development indicators (traffic reduction, energy savings) rather than long-term knowledge investment. Planning systems typically favor reactive, short-term responses over proactive strategies, and through the five-year rhythms of comprehensive plans, they reduce climate change to a technical issue of demand and consumption.

The second paradox is the disjuncture between high-frequency economic evaluation and low-frequency ecological valuation. The contrast between the high abundance of "economic evaluation" and the low frequencies of "green infrastructure assessment," "natural land management," and "assessment of impacts on natural areas" indicates that while climate costs are measured, nature-based solutions are largely absent from the plans. Reasons such as a preference for engineered solutions, institutional weakness, and the lack of a legal framework prevent green and blue infrastructure projects from achieving their desired outcomes. In the Isfahan metropolitan city, only those themes that align with conventional development indicators (GDP, employment, traffic reduction) are brought to the fore.

The third paradox is the differential reduction of mitigation targets in forward-looking plans. While the "Isfahan 95 with a strategic approach" and "Isfahan 1405 Strategic-Operational Plan" plans contain the highest frequencies of climate codes, the forward-looking "Isfahan 1410 Strategic Plan" includes less than 10% of these codes. Mitigation themes such as carbon sequestration and renewable energy are almost entirely eliminated, whereas adaptation themes such as water management are partially retained. This institutional tension between mitigation and adaptation is resolved along temporal lines: immediate economic concerns and water security persist, but the long-term imperatives of emission reduction are postponed.

These three paradoxes express a deep institutional logic. Themes that align with short-term economic growth and quick political payoffs are reproduced, while themes that require long-term knowledge investment, ecological valuation, or behavioral transformation become marginalized. The drastic reduction of climate themes in "Isfahan 1410 Strategic Plan" is a critical warning—it signals a systematic retreat from framing climate change as a central challenge for urban development. Overall, bridging this gap requires three structural interventions: (a) mandatory cross-sectoral mandates for the production and integration of climate knowledge, (b) financial instruments to rebalance incentives towards nature-based and mitigation-oriented investments, and (c) governance reforms to ensure accountability beyond electoral cycles.

Given that the pathology of the Isfahan metropolitan city reveals the dominance of demand-driven themes, the marginalization and low-frequency ecological valuation, and the differential reduction of mitigation targets over future horizons, a key question arises: is this pattern unique, or does it reflect a global institutional logic? Studies indicate that the prioritization of short-term responses over forward-looking strategies is not limited to the Isfahan metropolitan city. Various comparative studies confirm that planning systems in both developed and developing poles suffer from "temporal mismatch" [5,34,35,41,42]. What distinguishes the Isfahan metropolitan city is the absence of any mechanism linking short-term and long-term horizons.

Regarding the second paradox (abundance of economic evaluation, absence of low-frequency ecological valuation), this follows a global pattern in the Global South. Research on cities reveals barriers such as knowledge gaps, inappropriate incentives, and financial constraints [5,27,28]. Despite awareness of the benefits of ecological valuation, urban decision-makers prioritize grey infrastructure for short-term economic reasons [22,40,43,44,46,51,111,113]. the Isfahan metropolitan city fits this pattern, with the difference that framing climate as a demand-side issue has almost entirely eliminated any mention of natural solutions.

In contrast to the Global North, it should be noted that the obstacle is "technical capacity", not a lack of political will [27,28,34,35,41,42]. In South African, the challenge lies in cross-sectoral integration and monitoring [114,115]. But in the Isfahan metropolitan city, the problem is a "systematic retreat from framing climate as a fundamental development issue"; climate gradually disappears from the agenda. Thus, the Isfahan metropolitan city lies at the intersection of two global logics: the dominance of short-term engineering-economic responses [22,40,43,44,46,51,111,113] and planning behavior that avoids climate framing in systems lacking cross-sectoral mandates and policy continuity [114,115]. International experiences demonstrate that even in the poorest systems, scalable coordination can prevent climate collapse [40,43–45,51,111,113,115]. The absence of such mechanisms in "Isfahan 1410 Strategic Plan" places the city in the exceptional position of an "intelligent march toward climate retreat."

5. Conclusion

The main objective of this research is to explain how the hidden and explicit themes of approaches to addressing climate change are reflected in local development plans. In this study, an integrated reading of the "reflexive-network" analysis of themes enabled, in addition to clarifying the hidden and explicit themes of the local development plans of the Isfahan metropolitan city, the creation of a framework through which researchers can examine the extent to which global concepts presented in approaches to addressing climate change are localized within these plans. Furthermore, the analysis identified the existing gaps in climate policy within local development plans. Thus, this research enriches the international scientific literature in the field of evaluating the effectiveness of local development plans from the perspective of addressing climate change. In addition, the innovative analytical approach of this study can be used for comparative studies in other similar metropolitan areas.

From a policy-making perspective, examining the urban and regional development plans of the Isfahan metropolitan city shows that experts and policymakers give more prominence to strategies and policies related to adaptation than to those related to mitigation. This suggests that the experts and policymakers responsible for these plans are more focused on addressing short-term and current climate change problems and challenges, while long-term goals associated with mitigation have received less attention.

Furthermore, examining each development plan separately reveals that none of the plans presents sufficient overall coherence, continuity, or compatibility in their strategies and policies for counteraction. It is noteworthy that although the city and metropolitan area of Isfahan have been significantly affected by the impacts of climate change – ranging from the drying of the Zayandeh Rud River and water shortages to land subsidence and dust storms resulting from these droughts – major plans such as the "Province Development Plan" and the "Isfahan 1410 Strategic Plan", which are among the proposed frameworks for the city's future (2026 to 2031), show minimal attention and offer very few strategies or policies addressing approaches to combating climate change.

The results indicate that focusing on themes such as sustainable transport development, enhancing energy efficiency, integrated water resource management, and regional economic assessment is essential for

achieving climate resilience and improving urban quality of life. The results showed that the limited emphasis on climate change in the urban development plans of this metropolis is mainly due to budget constraints, lack of awareness, weaknesses in climate planning at both public and managerial levels, and institutional fragmentation. These factors have resulted in climate change being addressed in development documents merely as a recommendation or symbolic gesture, rather than as a strategic imperative.

Despite tangible crises such as the drying of the Zayandeh Rud River, land subsidence, and air pollution, continuing this approach could severely reduce the city's resilience and widen the gap between environmental necessities and the local development path. Bridging these gaps requires scientific, institutional, and policy convergence so that urban development not only meets short-term needs but is also compatible with long-term climate requirements.

It is therefore recommended that urban policy-making focus on three main pillars: Reforming economic priorities to incorporate climate goals alongside physical projects. The results of this study indicate that economic assessment, as a foundational theme of the adaptation approach, should focus on accurately estimating the potential level of vulnerability arising from climate change. Vulnerability, when it occurs, manifests as deficiencies and disruptions in the functioning of the urban system. Therefore, understanding the level of urban vulnerability and the capacity to adapt to climate impacts is critically important. This understanding can be analyzed at least at two distinct levels: first, from the perspective of the city as a whole and the manner in which urban development unfolds; and second, from an intra-urban perspective, in which the city is disaggregated to reveal the degree of access different social and demographic groups have to the determinants of adaptive capacity [22,36,42,43].

Enhancing climate culture and literacy is necessary to foster social demand, as awareness-raising and the dissemination of knowledge to reduce the impacts of climate change should involve a combination of scientific and practical education across all levels of education. High-quality education is a key component of adaptive capacity, as it equips all segments of society with the knowledge and skills needed to adapt livelihoods and ways of life to ecological, social, economic, and environmental changes, while also fostering problem-solving through the participation of local communities [22,36,42,43].

Ultimately, institutional integration can be achieved by clearly defining responsibilities in the mainstreaming of climate policies. Continuous assessment of the impacts of climate change on natural and protected areas, along with the timely and sustained implementation of adaptation strategies in urban, peri-urban, and rural areas, can enhance opportunities for the management, conservation, and restoration of ecosystems in natural and protected areas, thereby supporting the provision of ecosystem services and increasing resilience to climate change [22,36,42,43].

The specific findings of this study indicate that the restructuring of economic priorities in the Isfahan metropolitan city cannot be confined solely to enhancing the efficiency and quantity of physical development projects; rather, it necessitates the mandatory implementation of formal climate vulnerability assessments prior to the approval of any development plan, as well as the redefinition of economic justification based on the incorporation of long-term costs associated with climate risks such as drought, land subsidence, and urban heat islands. Concurrently, the enhancement of climate literacy must transcend general and abstract public education, moving towards problem-based capacity building at the neighborhood level, linking climate knowledge to the lived experience of Isfahan's citizens through the design of localized awareness campaigns and participatory initiatives—such as drought-resistant community gardens.

Ultimately, institutional integration will be achieved not merely through the formulation of high-level strategic documents, but rather by clarifying the missing link of accountability through the designation of a single responsible entity for urban climate governance, delegating to that body the authority to veto non-climate-compliant plans, and mandating the periodic revision of detailed and comprehensive plans based on climate vulnerability indicators. In this manner, the three aforementioned general pillars, by being embedded in the concrete realities of the Isfahan metropolitan city, move beyond generic prescriptions and transform into targeted, nuanced, and actionable policy recommendations applicable to the urban planning system.

These orientations can bring the issue of climate from the margins to the centre of the urban planning process and guide the development path of the Isfahan metropolitan city towards sustainable resilience. Thus, the results of this research can serve as a basis for revising urban and regional policies. Despite these achievements, the present study has also faced certain limitations.

One of the limitations of this study regarding the use of thematic analysis is that, given the nature of this method, if the volume of data increases, the analysis process becomes significantly time-consuming and complex, and this can make it difficult to extract coherent and meaningful themes. Accordingly, in order to maintain analytical coherence and allow for systematic data management, researchers have refrained from reviewing more documents. The study also faces spatial limitations because it focuses solely on the Isfahan metropolitan city, and applying its results to other cities requires comparative research. Conceptually, the research examines official development plan documents, while it considers informal urban management actions and the role of civil society less thoroughly.

To address these gaps, future studies should develop predictive models of urban-scale climate impacts, conduct comparative analyses between major cities in Iran and other regional countries, and investigate mechanisms of multi-level governance for mainstreaming climate policies. Additionally, examining innovative climate finance tools, such as urban carbon budgeting, can create new opportunities to link the urban economy with climate resilience.

CRediT authorship contribution statement

Hashem Dadashpoor: Writing – review & editing, Writing – original draft, Validation, Supervision, Project administration, Methodology, Formal analysis, Conceptualization. **Zahra Mahvash Mohammadi:** Writing – review & editing, Writing – original draft, Visualization, Validation, Resources, Methodology, Investigation, Formal analysis, Data curation, Conceptualization.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

Data will be made available on request.

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